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Commissioning progress of the first cryoplant for SHINE accelerator

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Content

01

Introduction

02

System Design and installation

03

Commissioning progress

04

Conclusion

SHINE

Introduction

SHINE

SHINE stands for Shanghai High repetition rate XFEL and Extreme light facility. SHINE facility is a quasi-continuous wave hard X-ray free electron laser facility, and will be located at the Zhangjiang High-tech Park of Shanghai Pudong.

The SHINE facility will be installed in the tunnels at the depth of **~29m** underground and with a maximum length of **3.1 km**.

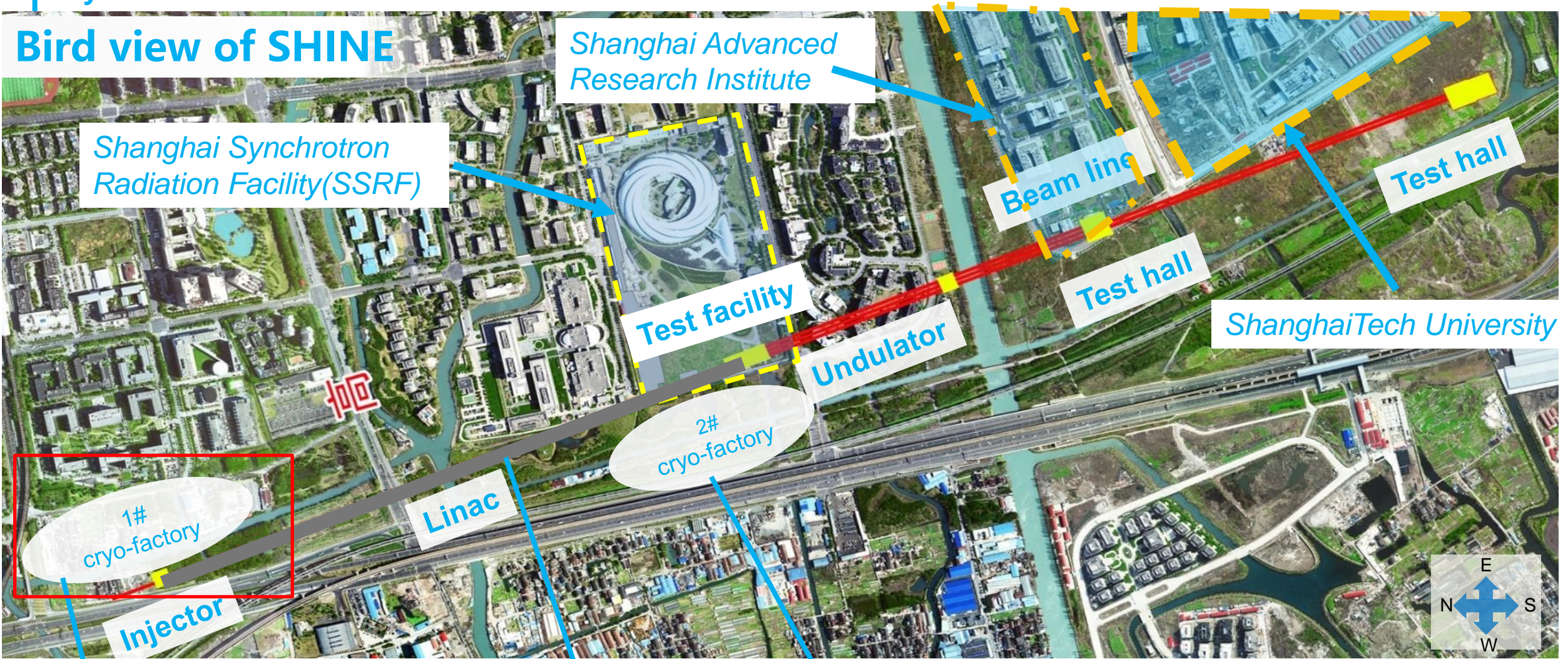
In its initial phase, the SHINE consists of an **8 GeV** continuous wave (CW) superconducting radio frequency linac, three undulator lines, three following FEL beamlines, and ten experimental end-stations.

A cryogenic factory with **12kW @ 2K** cooling capacity will support the operation of SHINE facility.

Introduction

Layout

Bird view of SHINE



2 sets of 4kW@2K cyroplants (for SHINE main facility)

Cryogenic multi-channel transfer lines

1 set of 4kW@2K cyroplant (for SHINE main facility)
1 set of 1kW@2K cyroplant (for SHINE test facility)



Content

01

Introduction

02

System Design and installation

03

Commissioning progress

04

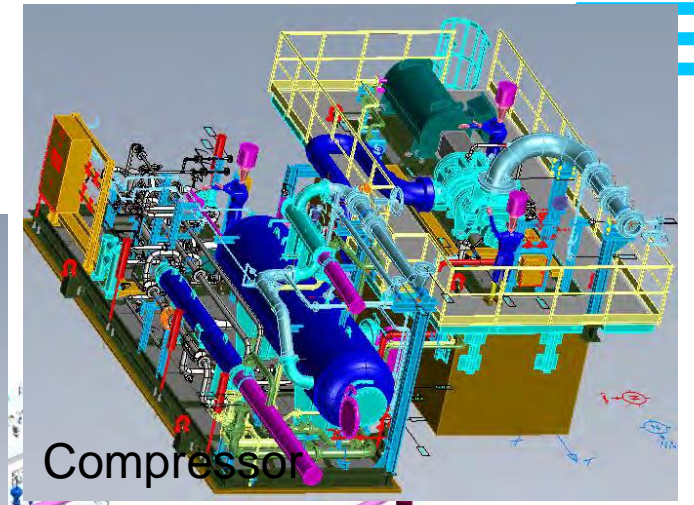
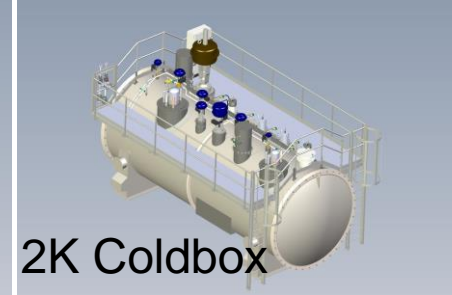
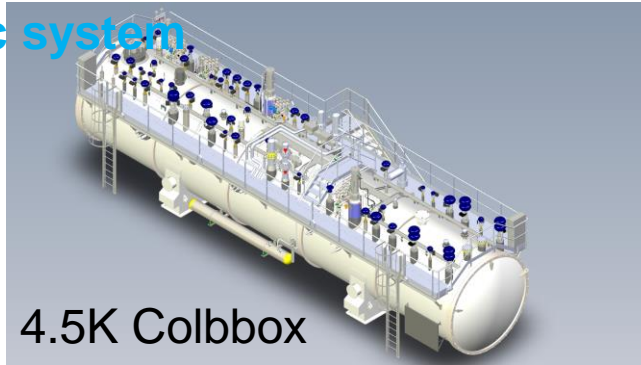
Conclusion

SHINE

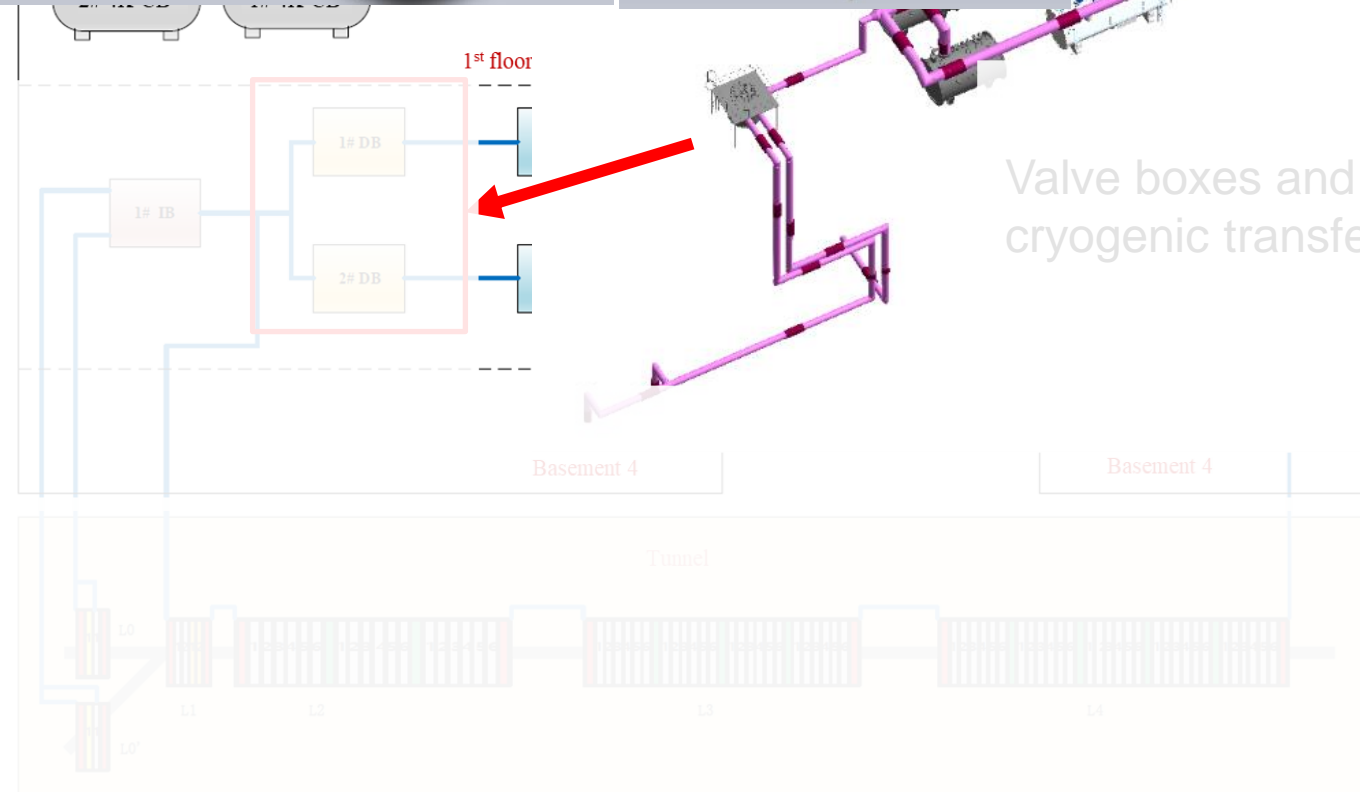
SHINE

Overall view of Cryogenic system

Cryoplant system



Cryogenic distribution system

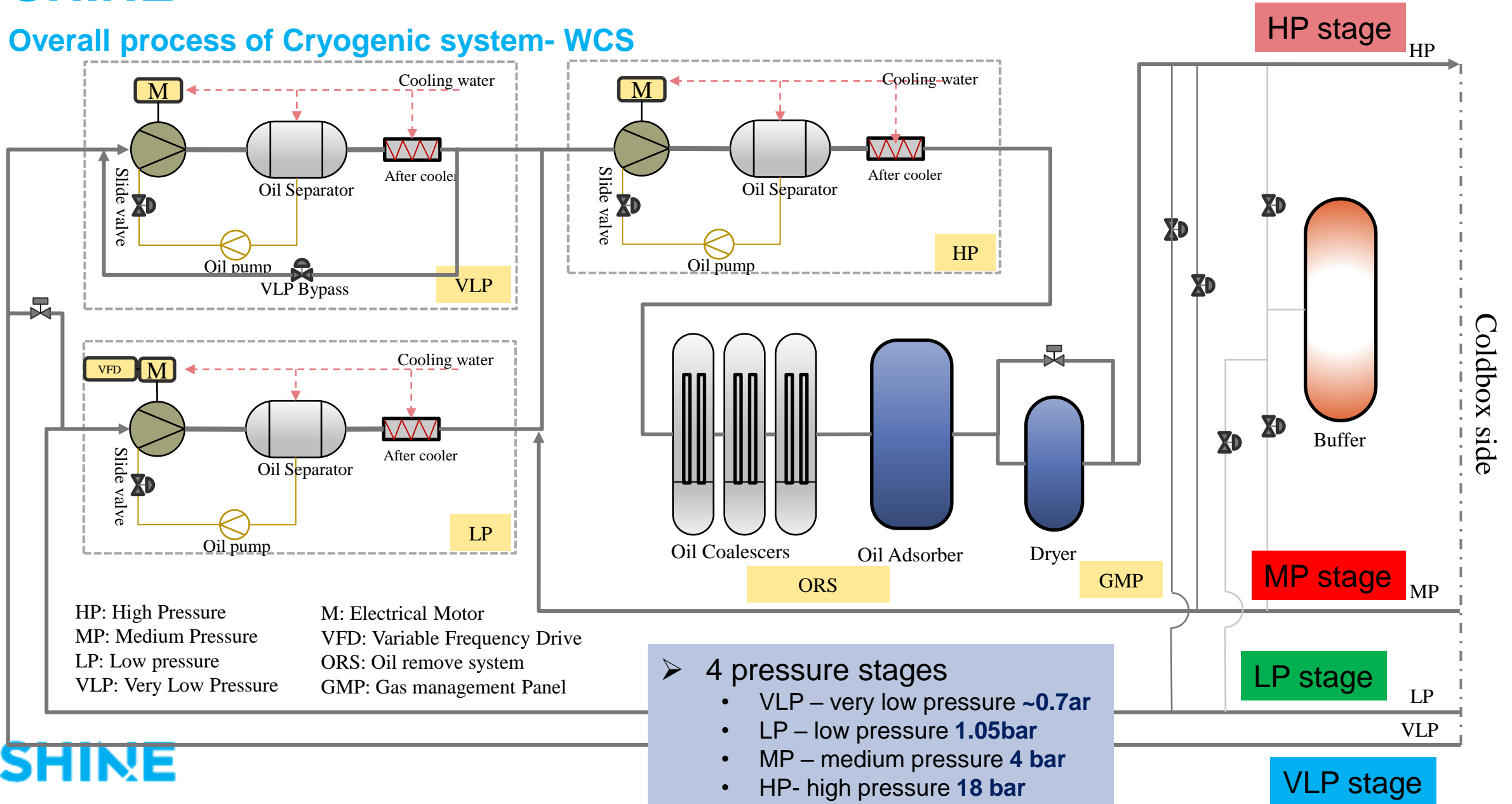


LINAC



SHINE

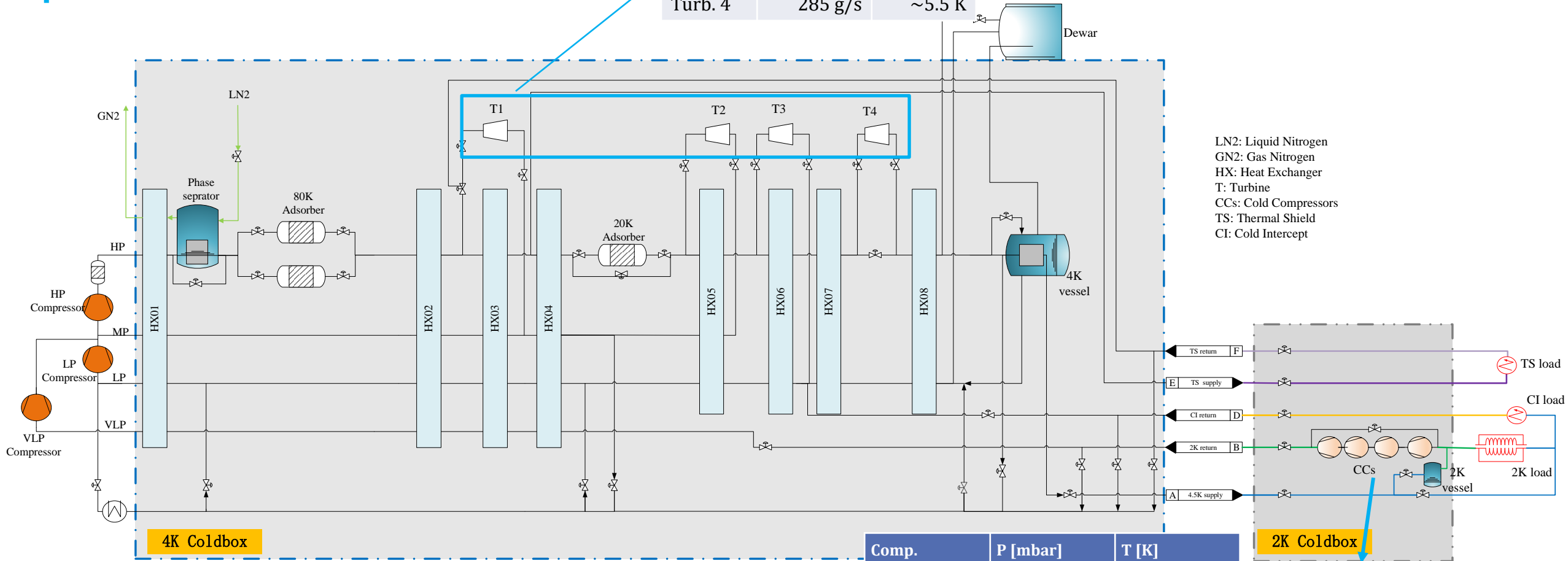
Overall process of Cryogenic system- WCS



SHINE

Overall process of Cryogenic system-CB

No.	Flow	T Out
Turb. 1	265 g/s	35 K
Turb. 2	230 g/s	17 K
Turb. 3	240 g/s	7K
Turb. 4	285 g/s	~5.5 K



LN2: Liquid Nitrogen
 GN2: Gas Nitrogen
 HX: Heat Exchanger
 T: Turbine
 CCs: Cold Compressors
 TS: Thermal Shield
 CI: Cold Intercept

Comp.	P [mbar]	T [K]
C1 Suct.	26	~4
C2 Suct.	85	~5
C3 Suct.	202	~10
C4 Suct.	410	~15
Total Flow:	~180 g/s	

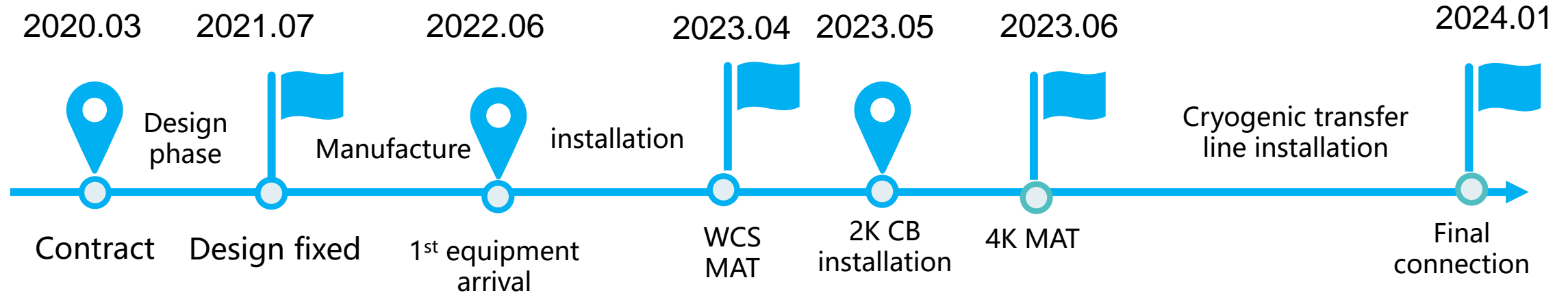




SHINE- Installation progress

SHINE 1st Cryoplant

Cryoplant installation milestones



- 2020.03 Contract with ALAT
- 2021.07 BDR1/BDR/DDR1/DDR2 Design fixed
- 2022.06 1st train of equipment arrived at site
- 2023.04 WCS1 MAT
- 2023.04 2K CB installation finished
- 2023.05 4K CB MAT
- 2024.01 4K CB & 2K CB final connection

SHINE

Bird view in shaft #1



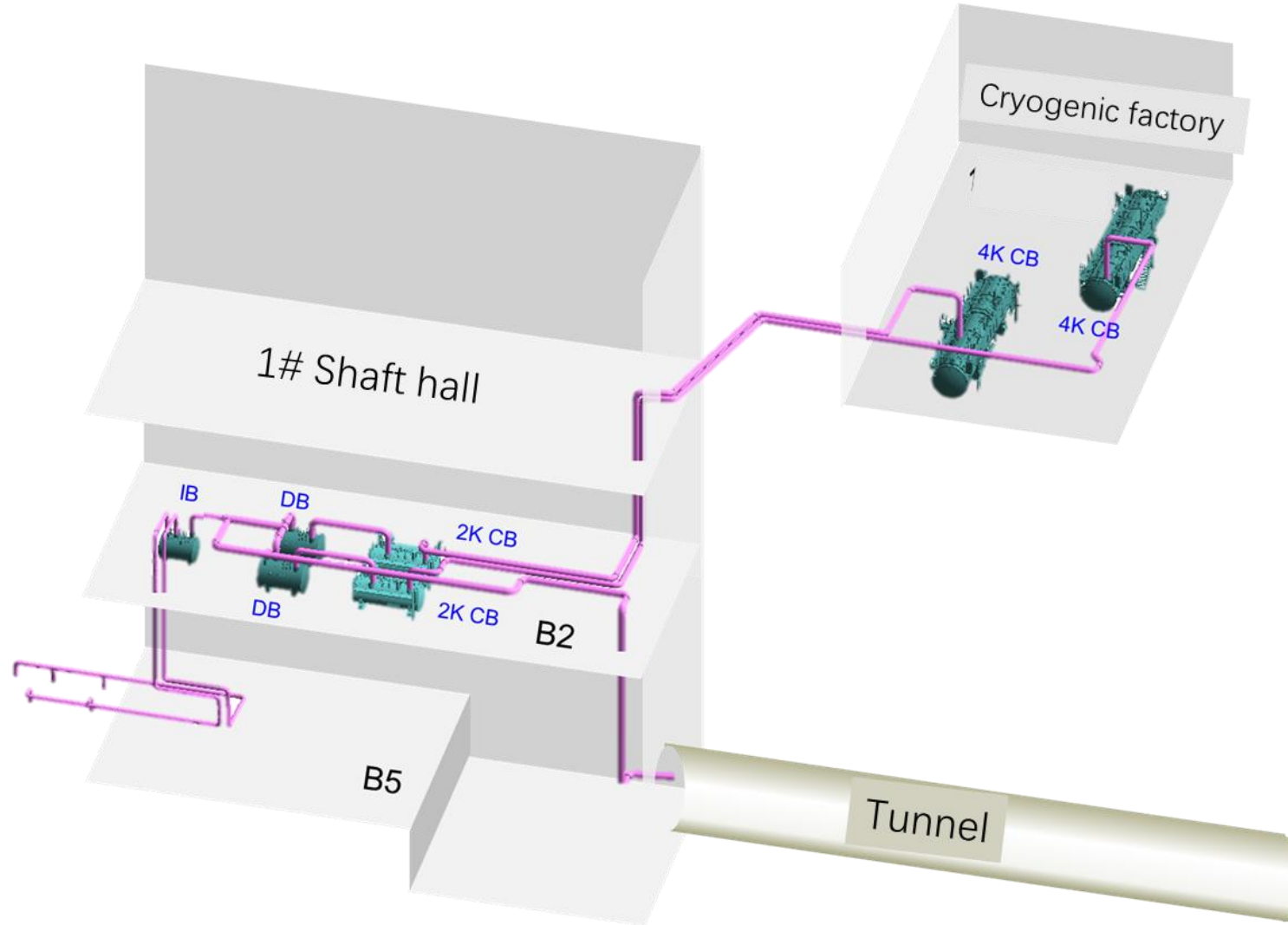
Cryogenic Hall

Shaft Hall

2023.03

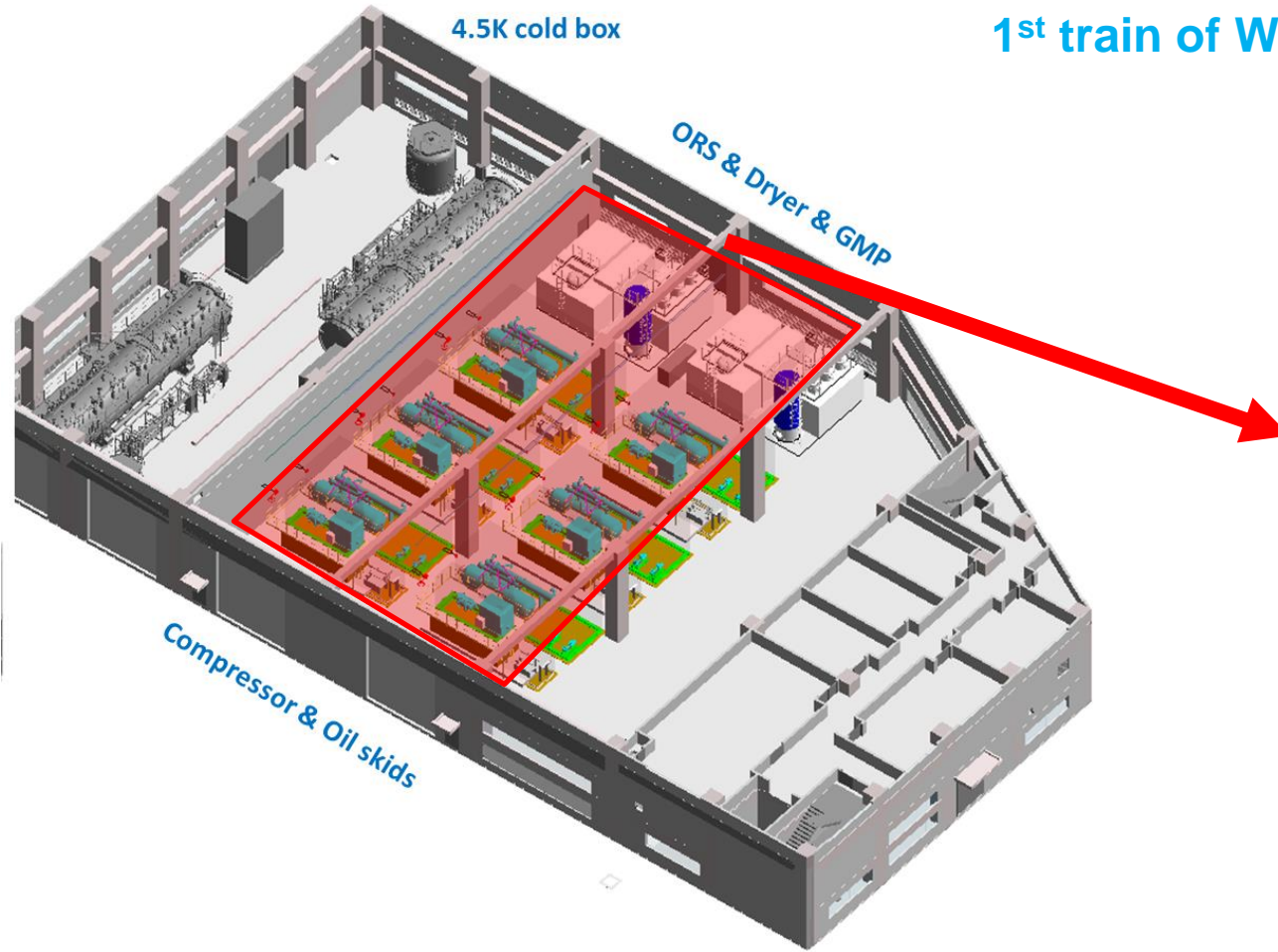
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Shaft 1



SHINE

Installation Progress

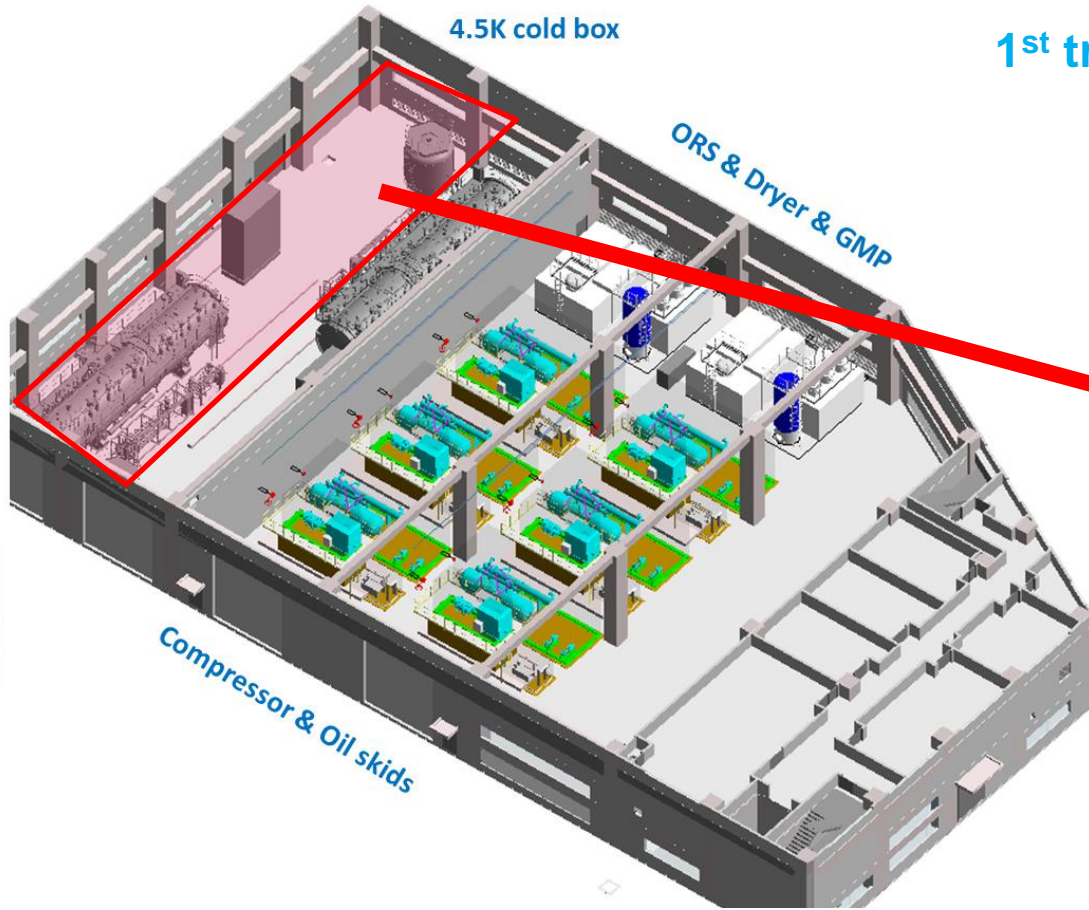


1st train of WCS installation finished at early April, 2023.

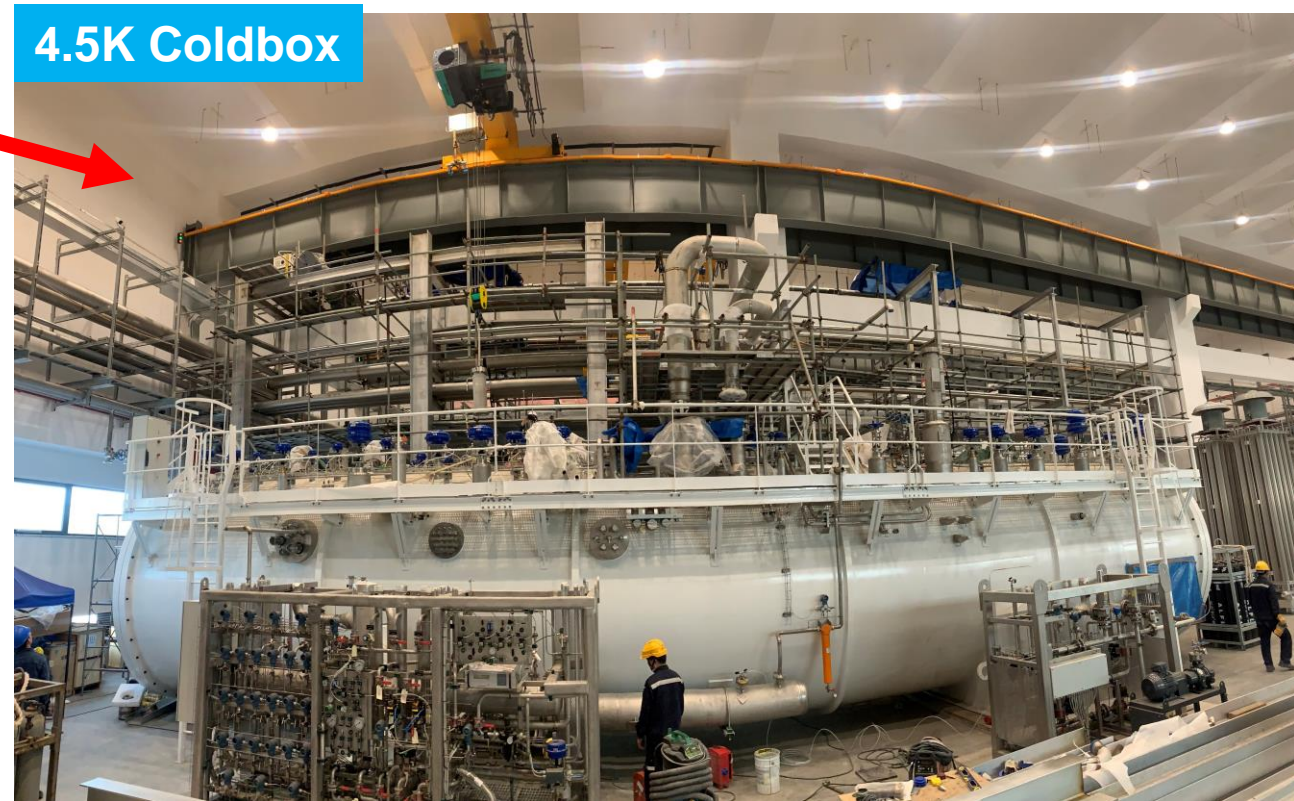


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Installation Progress-4K CB



1st train of 4K CB installation finished at early June, 2023.



Size: nearly

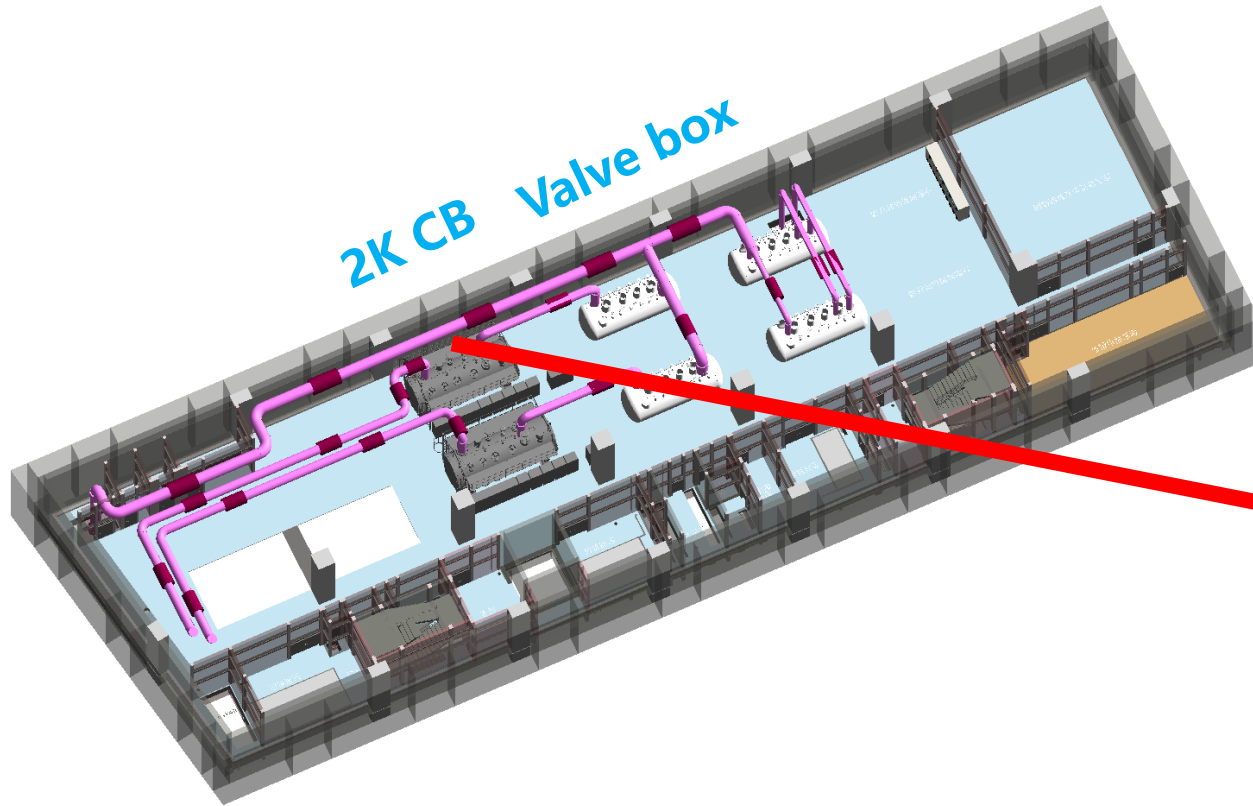
20000mm*5000mm*5000mm

Weight:

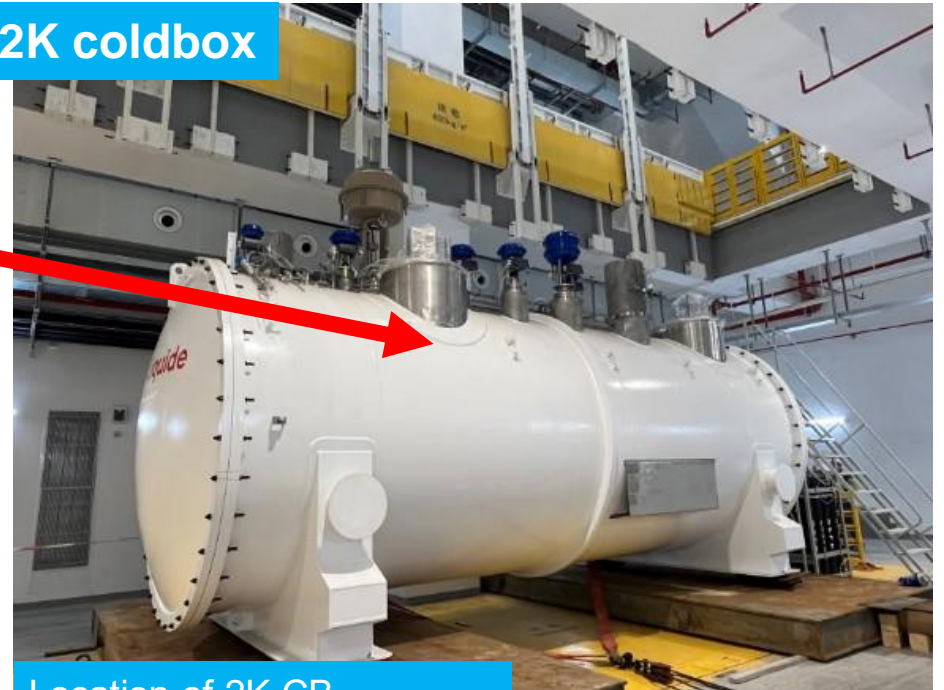
Nearly 90tons



1st train of 2K CB installation finished at July, 2023.



2K coldbox



Location of 2K CB

Content

01

Introduction

02

System Design and installation

03

Commissioning progress

04

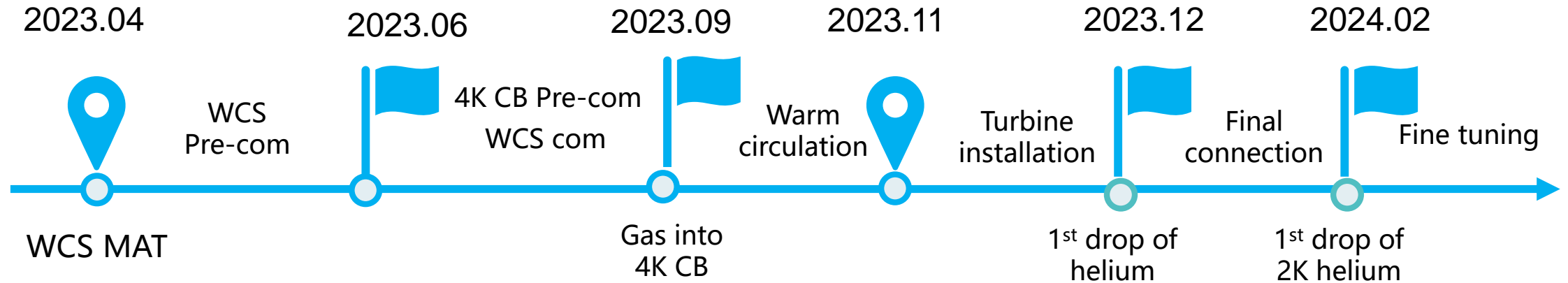
Conclusion



SHINE

SHINE 1st Cryoplant

Cryoplant milestones



2023.04 WCS pre-com & com Starts

2023.06 4K CB pre-com starts

2022.07 WCS Performance test

2023.09 Warm circulation

2023.12 1st drop of liquid helium

2024.01 4K CB & 2K CB final connection

2024.02 1st drop of 2K helium

SHINE

WCS commissioning Progress

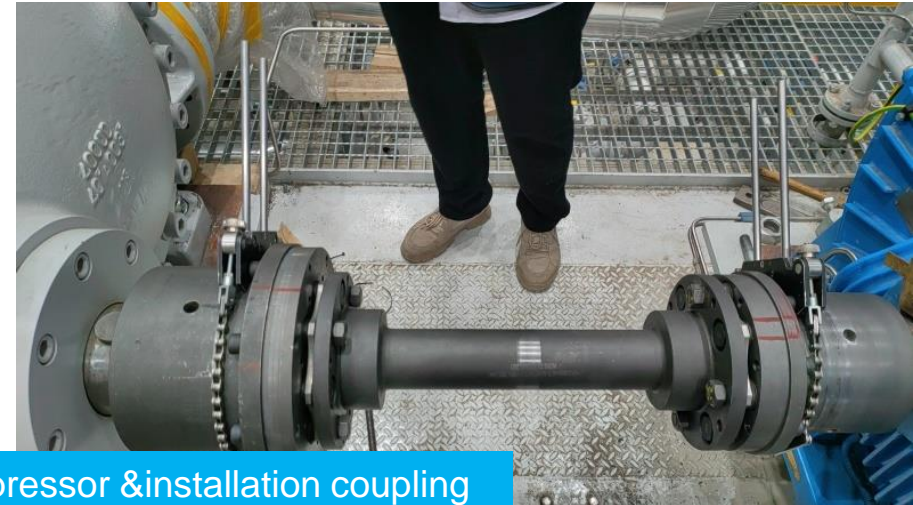
WCS pre-commissioning starts at early April.

Pre-commissioning of WCS:

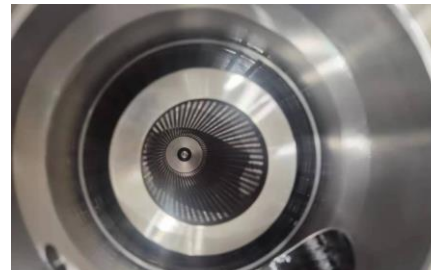
- ✓ Mechanical check(adsorbers /filters...)
- ✓ Loop check+ alarm Fault check
- ✓ Oil pump leveling and coupling installation
- ✓ Main compressor leveling & coupling installation
- ✓ Compressor oil filling & oil flushing
- ✓ Motor bump test & solorun
- ✓ Adsorber +Dryer Regeneration
- ✓ Final oiling filling & conditioning
- ✓ Functional check



Leveling the compressor and motor soft feet test



Aligning of compressor & installation coupling



Oil flushing and filter check



Functional and performance test

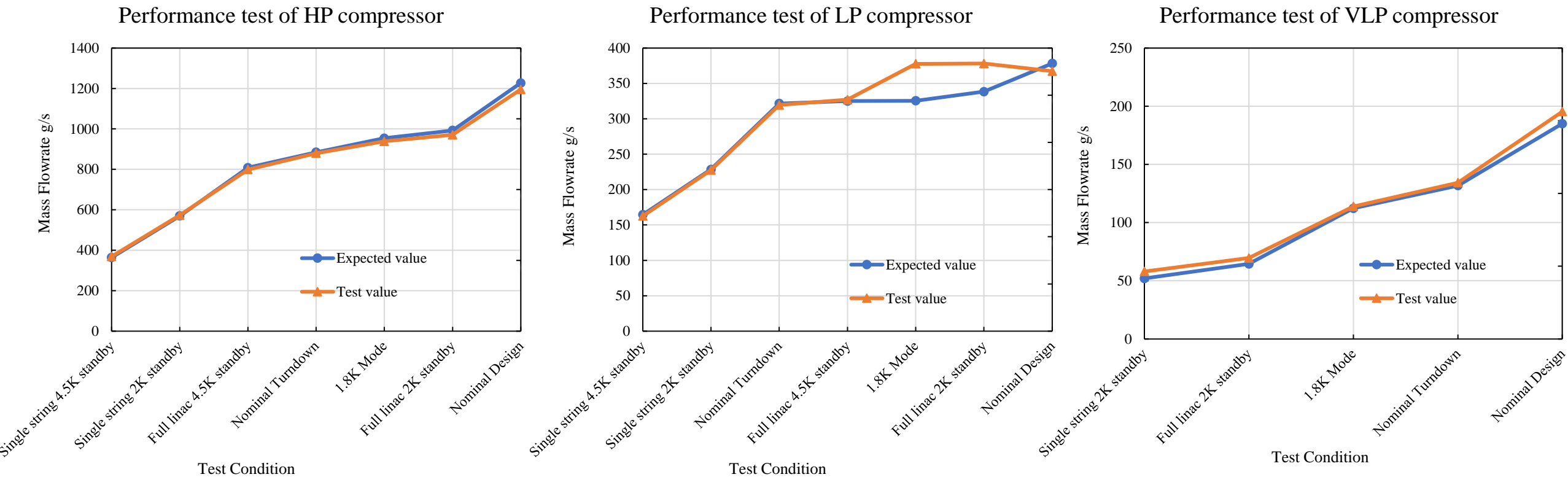


Figure 1: Mass flowrate test results under different test modes

Functional and performance test

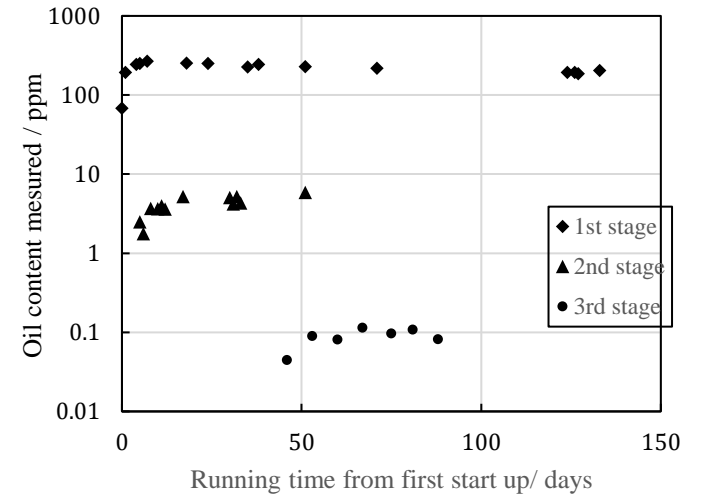
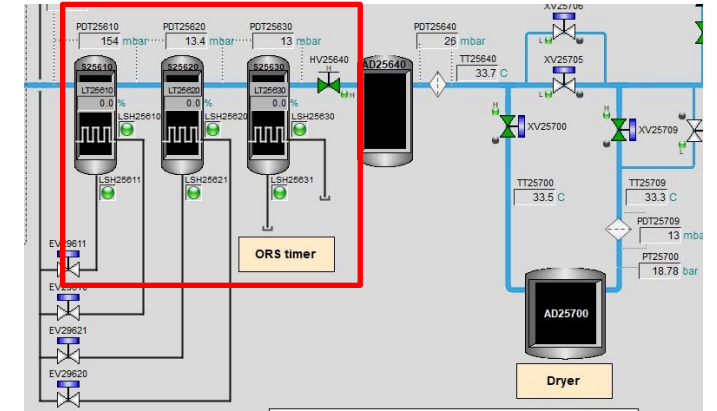
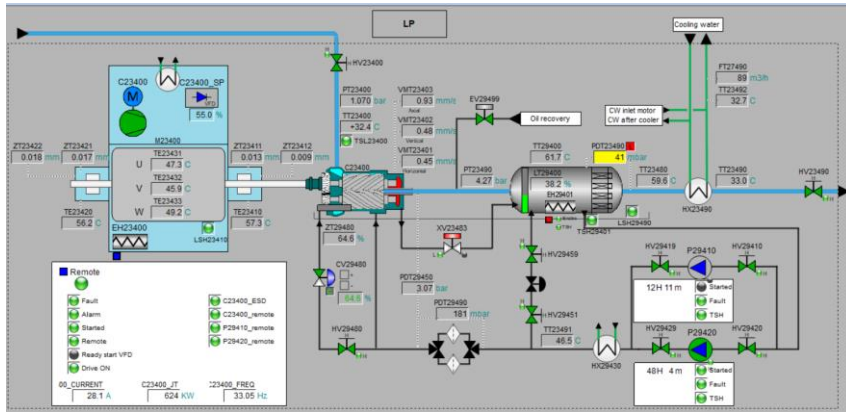
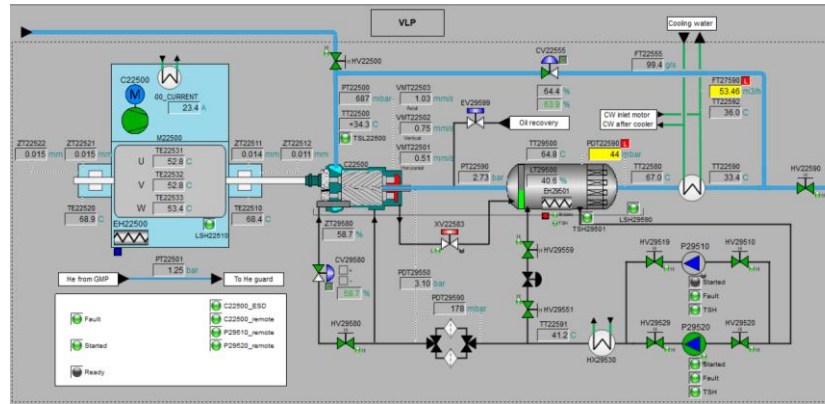
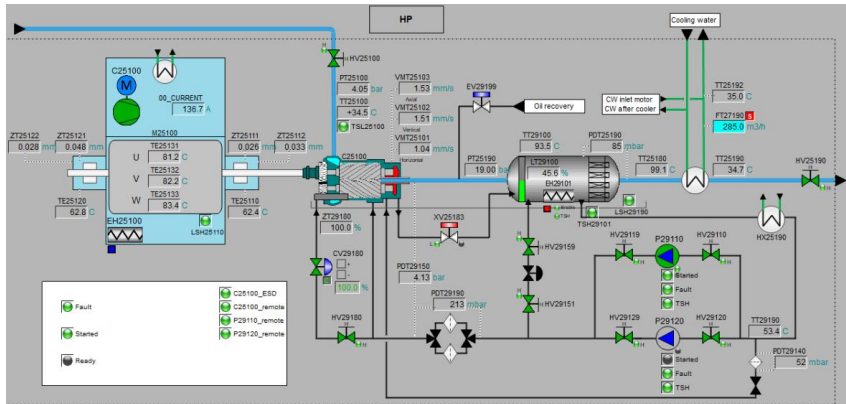


Figure 2: Oil content at the inlet of Coalescer changes with WCS running time

Table1: Vibration & Noise test results

Nominal operation mode	VLP	LP	HP
X direction(<7.5mm/S RMS)	1.045	0.29	1.16
Y direction(<7.5mm/S RMS)	1.015	0.18	0.96
Z direction (<7.5mm/S RMS)	0.505	0.46	1.42
Noise (@ 1m,Db)	93	89	91

Trip / start and stop test



Warm circulation

From early September to end of November 2023.

First time of check



Last time of check



Adsorber filter

Particles



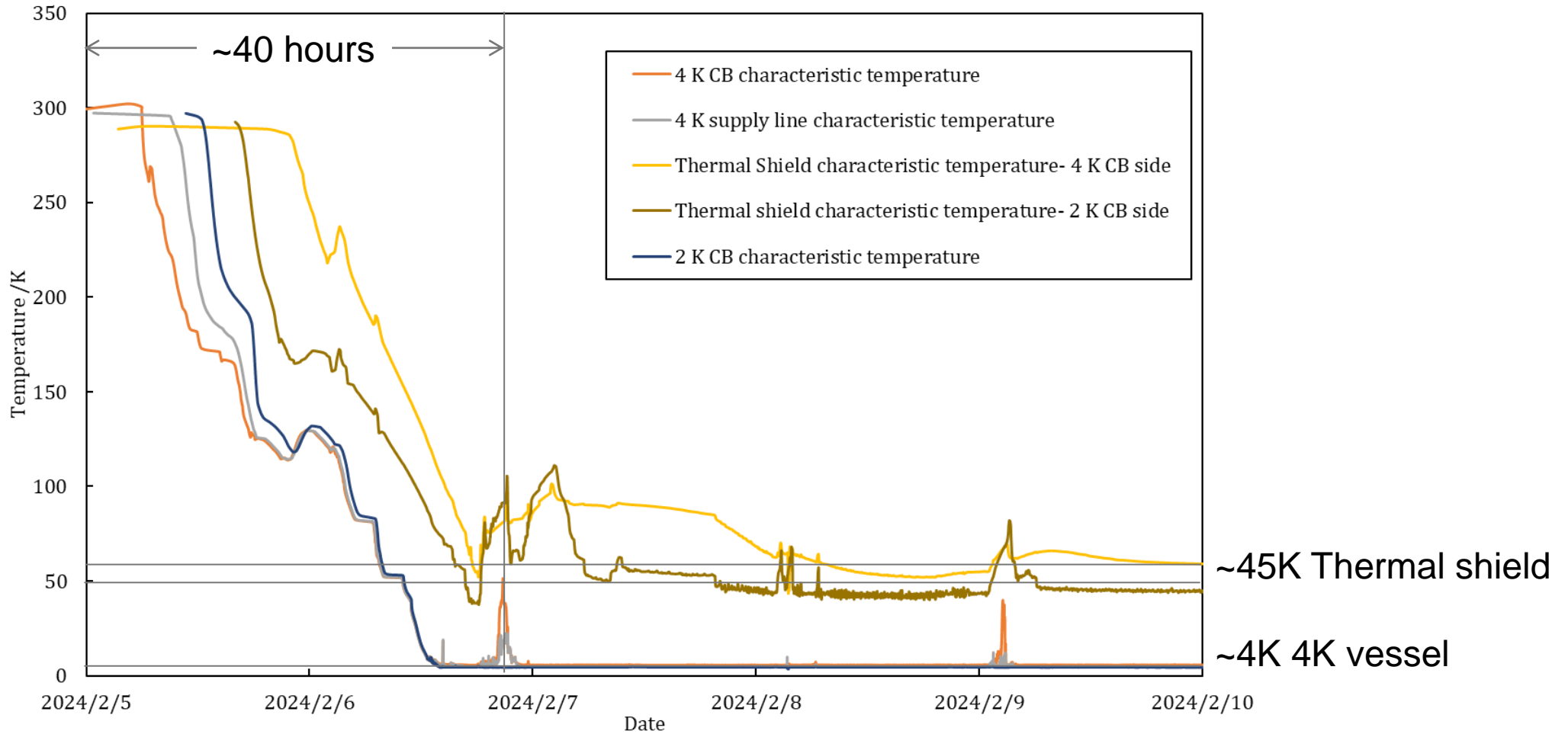


Figure3: The characteristic temperature changes during cooling down progress

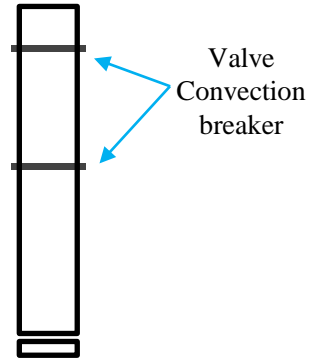
SHINE

Trouble shooting

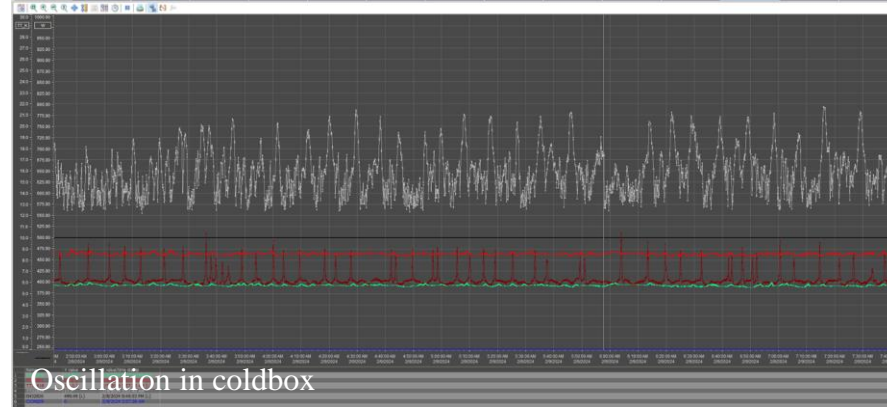


New gasket and cartridges are installed to improve the performance of ORS

WCS



Valve Convection breaker were involved to reduced the gas flow



Gas bottle and gas mixer are involved to decrease the oscillation



The pipe structure will be modified to mitigate the oscillation in coming days.



Installation and commissioning

- Detailed communication with Construction / utility department should be done to avoid misunderstanding.
- Enough manpower and spare parts are necessary if you want to speed up the installation.
- Important Tools (torque machine, leak detector...) need to be calibrated and checked before using.
- Never relax the quality standards (cleanness., welding...), otherwise you will pay 5 times effort to fix problems.
- Enough helium is necessary for start-up, but not too much helium connect to system during commissioning phase.

WCS

- Cleanness check and filter check are very important for start-up.
- Purifier is useful especially if you want to save helium during commissioning.
- Oil content of Gas at outlet of ORS need to be monitored regularly especially during the first month of running.
- The N₂ impurity will influence the analyzer's measurement of oil content.
- Pay attention to the cooling water if you want stable operation (water quality, flowmeter type...)

CB

- Vacuum for CB and cryogenic line need to be start as early as possible if you want to speed up.
- Cleanness of the adsorber filters and turbine inlet filters are very important.
- Warm circulation of the whole system should be done if possible.
- Get the Spare turbines ready before you start the cryoplant.

Content

01

Introduction

02

System Design and installation

03

Commissioning progress

04

Conclusion

A photograph of the Shanghai skyline at dusk, featuring the Oriental Pearl Tower and other skyscrapers. The word "SHINE" is overlaid in large white letters at the bottom left.

SHINE



- The Cryogenic system for SHINE have been designed and the 1st train Cryoplant have been installed successfully.
- The 1st cryoplant is under fine tuning and will conduct the performance test in coming month.
- The trouble-shooting and lesson learned have been shared.



Thanks for your attention

Q & A

Be
SHINE

Special thanks to,
SHINE cryogenic team &
ALAT & MYCOM and related supplier.

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